coilsep

In order to get large accsess to the plasma for diagnostics, it's better to have bigger separations between adjacent coils. To find a continuous cost function, we assume two coils are charged electric lines and do a double integral to calculate their electric potential as the coil-coil separation cost function. We can also try to calculate magnetic forces between two coils which may be more pratical for engineering consideration.

[called by: denergy.]

contents

1.1 Cost function (0 order)

For two adjacent coils, coil i and coil j, the electric potential between them are written as,

$$C = \sum_{i,j=1}^{Ncoils} \int_{c_i} \int_{C_j} \frac{dl_i \; dl_j}{\delta r^2} \tag{1}$$

where, $dl_i = \sqrt{\dot{x_i}^2 + \dot{y_i}^2 + \dot{z_i}^2}$, $dl_j = \sqrt{\dot{x_j}^2 + \dot{y_j}^2 + \dot{z_j}^2}$ and $\delta r = \sqrt{(x_j - x_i)^2 + (y_j - y_i)^2 + (z_j - z_i)^2}$. And using the square of δr actually makes the funtion dimensionless.

Note: Since the differential arc length is included in the cost function C, minimizing the function C would lead coils compressed to point, as well as increasing their separation. Another idea is summing up the distance between two points of the same poloidal angel on the two coils, rather than doing a double integral over the whole coils.

1.2 First derivatives

The first derivative of function C on the x_m term of coil i can be written as,

$$\frac{\partial C}{\partial x^i_m} = \int_{c_{i-1}} \int_{C_i} \frac{dl_{i-1} \; dl_i}{\delta r^2} \; + \; \int_{c_i} \int_{C_{i+1}} \frac{dl_i \; dl_{i+1}}{\delta r^2} \tag{2}$$